THE TAMILNADU Dr.M.G.R MEDICAL UNIVERSITY

ANALYSIS OF TENTORIAL NOTCH IN INDIAN POPULATION, COMPARING IT WITH WESTERN POPULATION AND ANALYSING THE RELATION BETWEEN TENTORIAL NOTCH SIZE AND THE OUTCOME OF HEAD INJURY PATIENTS

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DECLARATION

I solemnly declare that this declaration entitled "ANALYSIS OF TENTORIAL NOTCH IN INDIAN POPULATION, COMPARING IT WITH WESTERN POPULATION AND ANALYSING THE RELATION BETWEEN TENTORIAL NOTCH SIZE AND THE OUTCOME OF HEAD INJURY PATIENTS" was prepared by me in the Institute of Neurology, Madras Medical College and Rajiv Gandhi Government General Hospital, Chennai- 3 from January 2013 to December 2013.

This dissertation is submitted to The Tamil Nadu Dr.M.G.R Medical University in partial fulfilment of university requirements for the award of degree of M.Ch. Neurosurgery.

Place: Chennai

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CERTIFICATE

This is to certify that the dissertation entitled "ANALYSIS OF TENTORIAL NOTCH IN INDIAN POPULATION, COMPARING IT WITH WESTERN POPULATION AND ANALYSING THE RELATION BETWEEN TENTORIAL NOTCH SIZE AND THE OUTCOME OF HEAD INJURY PATIENTS" is a bonafide work done by Dr.S.Maria Subison at Institute of Neurology in partial fulfilment of the University rules and regulations for award of M.Ch. Neurosurgery under my guidance and supervision during the academic year 2014.

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CONTENTS

INTRODUCTION

Introduction

The tentorial incisura is the hiatus through which supra tentorial and infra tentorial space communicated. The knowledge about anatomy of tentorium and tentorial incisura is more important for various surgical approaches both for supratentorial as well as infra tentorial

Size of the tentorial incisura is varies from person to person even in same age. Size of the tentorial incisura plays important role in tentorial herniation which happened due to supratentorial haematoma or supra tentorial space occupying lesion.

There are only few studies in the literature analyzing the size of the tentorial incisura and analyzing the correlation between the tentorial incisura size and tentorial herniation. There are hardly any studies available in the literature analyzing the tentorial size of Indian population and its clinical importance.

Here an attempt has been made to study the tentorial incisura size in Indian population both in cadaver and in autopsy cases, size of incisura in autopsy cases also analyzed with patient clinical condition to find out any relation between tentorial incisura size and tentorial herniation

AIM OF THE STUDY

Aim of the study

Aim of the study is measurement of tentorial notch size in Indian population comparing it with western population from the literature available and analyzing the relation between tentorial notch size and the outcome of head injury patients.

REVIEW OF LITERATURE

Review of literature

Anatomy of tentorial incisura

Neural and vascular relationship in the tentorial hiatus is more complex. Tentorial incisural area contains carotid artery bifurcation, basilar artery bifurcation and circle of Willis. This is also related to deep intracranial venous system which converges to great vein of Galen. Neural structures related to tentorial incisura are cerebrum, cerebellum, olfactory, optic, occulomotor, trochlear, trigeminal, abducent nerve and midbrain[1].

The tentorial incisura is the opening which connects the supra and infratentorial spaces. There is a space between the midbrain and tentorial edges; this incisural space is divided into anterior incisural space, middle incisural space, and posterior incisural space[2]

Incisura is triangular in shape, base is situated anteriorly over dorsum sellae and apex is situated posteriorly dorsal to the midbrain and pineal gland. Some variations may be there in the tentorial incisura because of the developmental defects[3].

As described earlier, incisural space is divided into 3 spaces, anterior, middle and posterior incisural spaces. Each space can be described by its neural, arterial, cisternal, ventricular, cranial nerve and venous relationship.

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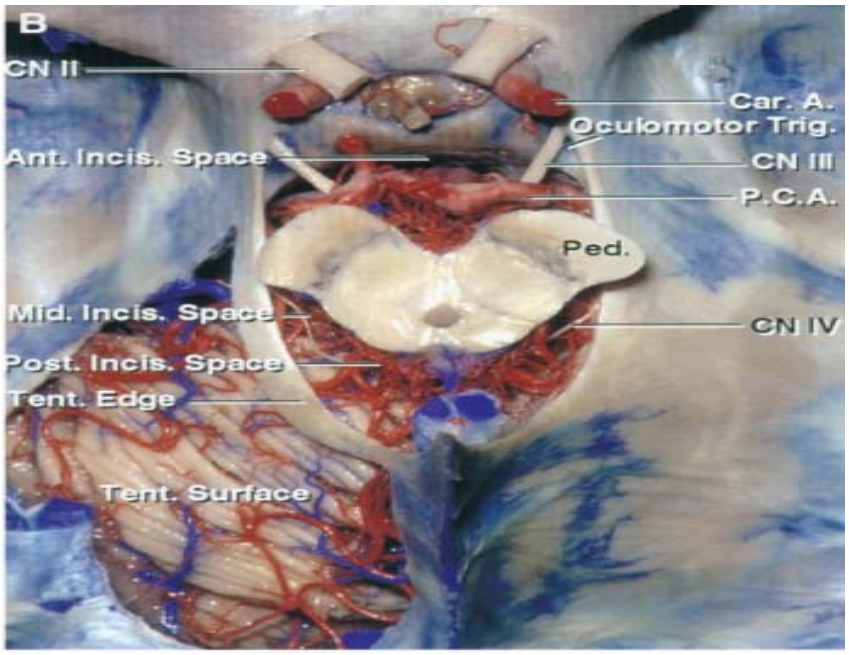
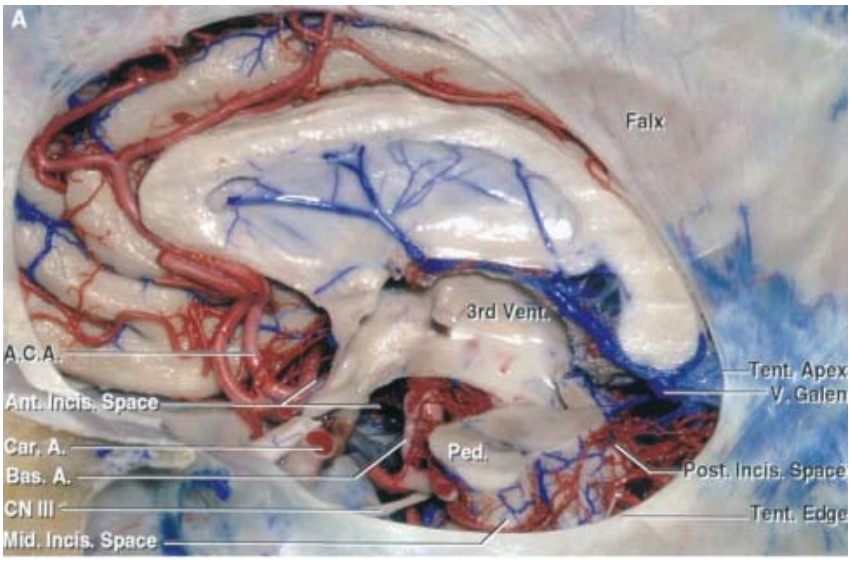


Picture 1: Tentorial incisura axial view



Picture 2: Tentorial incisura sagittal view

ANTERIOR INCISURAL SPACE

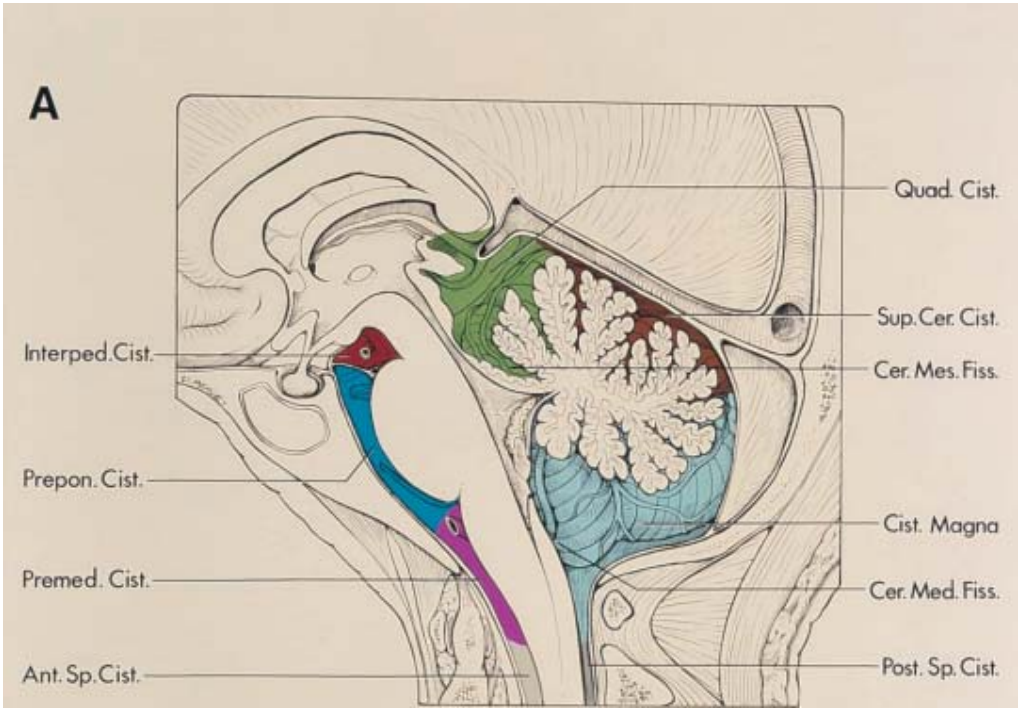
Neural relationships

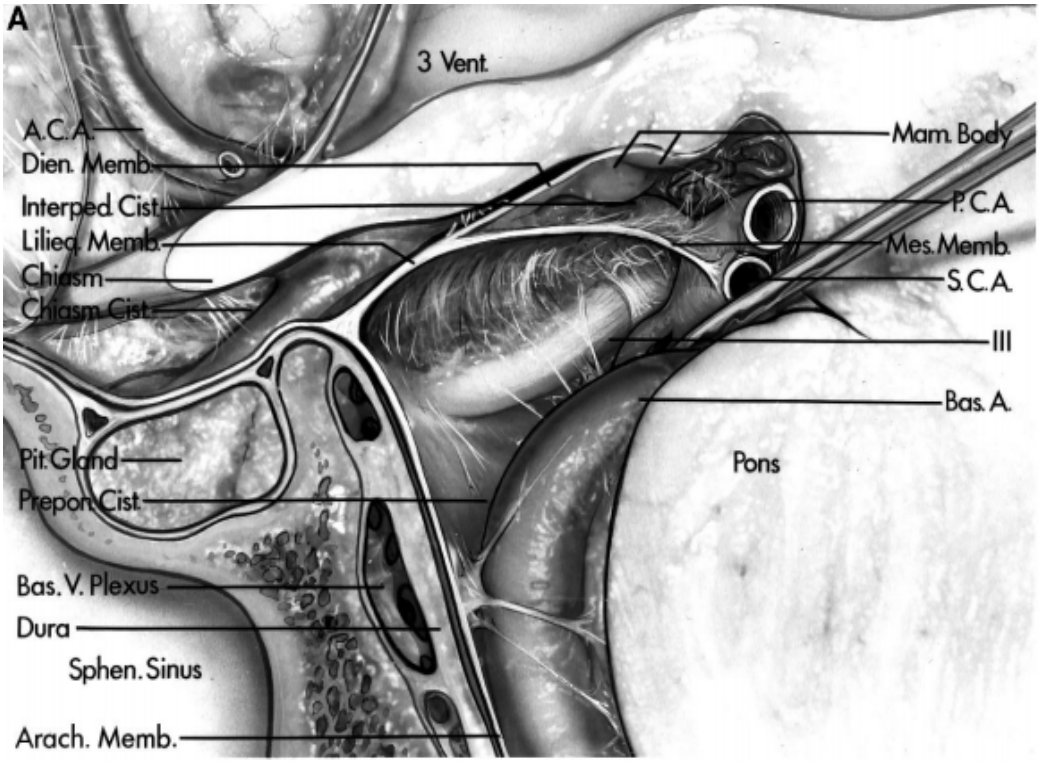
Anterior incisural space is situated in front of upper brain stem, that is between the midbrain and pons posteriorly and clivus posteriorly. This space communicated laterally with sylvian fissure and posteriorly with middle incisural space.

Upper part of anterior incisural space is located above the optic chiasm, which is bounded superiorly by the rostrum of carpus callosum,laterally by medial surface of frontal lobe and posteriorly by lamina terminalis.

Cisternal relationships

Anterior incisural space has interpeduncular cistern which is situated between two crura of midbrain,interpeduncular cistern communicates with sylvian cistern laterally and chiasmatic cistern anteriorly.Lilliquist membrane separates interpeduncular and chiasmatic cistern. Chiasmatic cistern is situated below the optic chiasm which has the communication with lamina terminalis cistern which is located in front of lamina terminalis.





Picture 3&4: Sagittal section showing cisterns

Ventricular relationships

Anterior incisural space related to anterior part of third ventricle. Anterior incisural space divides the third ventricle into supra chiasmatic and infra chiasmatic portions. Anterior incisural space also related to frontal horns of lateral ventricle which is located above this space. Temporal horn of lateral ventricle separated from anterior incisural space by uncus.

Cranial nerves

Cranial nerves related to anterior incisural space are, posterior part of olfactory nerve, optic nerves and occulomotor nerves. Olfactory tract runs antero posteriorly and divides into medial and lateral olfactory striae just above anterior clinoid. Optic nerves coming out of optic foramen medial to anterior clinoid process, this runs towards the optic chiasm. Optic chiasm normally situated above the diaphragm sellae in 80 percentage of population in 10 percentage of population, it can situated above tuberculam sellae which is called as prefixed, in remaining 10 percentage it can situated over dorsum sellae which is called as post fixed chiasm. Optic tract runs in the postero lateral direction around the cerebral peduncle from the chiasm and enter into the middle incisural space. Occulomotor nerve arises from the anterior surface of midbrain, runs between the posterior cerebral artery (PCA) and superior cerebellar artery (SCA), and passes medial to the uncus to enter into the cavernous sinus. Sixth cranial nerve arises from the Ponto medullary junction and runs in the infra

tentorial part of anterior incisural space that is in the prepontine cistern, it passes below the petro sphenoidligament (dorolos canal) and enter into the cavernous sinus.

Arterial relationships[2, 4]

Anterior incisural space related to internal carotid artery, Posterior communicating artery (PCom), anterior choroidal artery (AChA), Middle cerebral artery (MCA), basilarartery, PCA and SCA

Venous relationships

Major vein related to anterior incisural space is basal vein of Rosenthal. This vein originates below the anterior perforated substance, runs around the midbrain in the anterior incisural space, middle incisural space, and posterior incisural spaceand drains to great vein of Galen.

MIDDLE INCISURAL SPACE

Neural relationships

Neural structures related to middle incisural space are upper brain stem, temporal lobe, and cerebellum. Medial wall of middle incisural space is bilaterallyformed bythe lateral surface of midbrain and upper pons. Sulcus between the midbrain and pons is called as Ponto mesencephalic sulcus which is situated at the level of tentorial free edge. Midbrain related to middle incisural space is divided into cerebral peduncle and tegmentum. Cerebral peduncle forms the larger anterior part of midbrain and tegmentum forms the smaller posterior part of midbrain in the middle incisural space. This cerebral peduncle and tegmentum separated by lateral mesencephalic sulcus. This lateral mesencephalic sulcus is a vertical sulcus extending from pulvinar of the thalamus above to the Ponto mesencephalic sulcus below. Roof of middle incisural space is narrow anteriorly and wide posteriorly, anterior part formed by optic tract and posterior part formed by inferior surface of thalamus which has lateral geniculate body protruded from it lower surface. Medial geniculate body also located in the lower part of thalamus but it protruded postero medial to lateral geniculate body in the roof of middle incisural space. Lateral border of middle incisural space formed by hippocampal formation in the upper part and uncus and parahippocampal gyrus in the lower part.Posterior to uncus medial surface of temporal lobe that is lateral wall of middle incisural space has three

parts of neural tissue, they are parahippocampal gyrus inferiorly, dentate gyrus in middle and fimbriae of fornix superiorly, all this three parts are interlocked by hippocampal formation which plays important role in forming the limbic system. Fibers from hippocampus together join and form the crus of the fornix.

Middle incisural space is communicated with cerebellomesencephalic fissure inferiorly. Cerebellomesencephalic fissure situated between cerebellum and lateral surface of midbrain.

Cisternal relationships

Crural and ambient cisterns are related to middle incisura. Crural cistern is located postero lateral to interpeduncular cistern. Crural cistern has communication with interpeduncular cistern anteriorly and ambient cistern posteriorly. Boundaries of ambient cistern are, medially midbrain, laterally parahippocampal, dentate and fimbriae of fornix, superiorly pulvinar of thalamus. Ambient cistern communicated posteriorly with quadrigeminal cistern.

Ventricular relationships

Ventricle related to middle incisural space are, temporal horn of lateral ventricle and body of lateral ventricle. Anterior limit of temporal horn is 3 cm posterior to temporal pole. Bodies of lateral ventricle situated above the middle

part of middle incisura. These paired bodies of lateral ventricle separated from the middle part of middle incisura by the thalamus

Cranial nerves[2,5]

Cranial nerves related to middle incisural space are fourth and fifth cranial nerves. Fourth nerve has the longest course within incisural space compare to all cranial nerves. Among all cranial nerves fourth nerve is intimately related to the tentorial edge. Origin of fourth is from the posterior part of midbrain below the level of inferior colliculus. From the origin fourth nerve passes in the posterior incisural space to the middle incisural space, there it run between posterior cerebral artery (PCA) and superior cerebellar artery (SCA).In the course of the fourth nerve initially it runs in the medial part of incisural space and later it runs in the lateral part of incisural space and reaches in the free edge of tentorium at the level of posterior edge of cerebral peduncle. Fourthnerve enters into the cavernous sinus in the posterior part of occulomotor triangle in the roof of the cavernous sinus and enters into the lateral wall of the cavernous sinus. Fifth cranial nerve originated from antero lateral part of middle of the pons, it runs towards the apex of the petrous bone and enter into Meckel's cave which is located in the antero medial part of petrous bone in the middle cranial fossa. As various cranial nerves are situated in and around the tentorial incisura, lesions in this area (meningioma[6,7,8,9,10],glioma,Dural AVM[11],dural AV fistula[12]etc…)produces various cranial nerve palsies[13].

Arterial relationships

Arteries related to middle incisural space are anterior choroidal artery, posterior cerebral artery (PCA) and superior cerebellar artery (SCA).Anterior choroidal artery enters the middle incisural space and enters into the temporal horn of lateral ventricle by piercing at inferior choroidal point. Anterior choroidal artery supplies the choroid plexus in the temporal horn of lateral ventricle. Choroid plexus is situated in the choroid fissure.

Posterior cerebral artery (PCA) after origin enters into middle incisural space running between midbrain and uncus. It gives of many cortical branches. These cortical branches cross the free edge of tentorial incisura and supply the inferior surface of occipital and temporal lobes. Apart from cortical branches posterior cerebral artery (PCA) gives of thalamo geniculate arteries and lateral posterior choroidal arteries in the middle incisural space.Lateral posterior choroidal arteries after origin in the middle incisural space runs superolaterally to reach the choroid plexus in the temporal horn and atrium of lateral ventricle.

Medial posterior choroidal artery originated from the proximal part of Posterior cerebral artery (PCA) in the anterior incisural space and courses through middle incisural space to reach the posterior incisural space where it courses below the splenium of carpus callosum to enter into the roof of the third ventricle.

Thalamo geniculate arteries after arising in the middle incisural space pass upward to supply the thalamus and internal capsule.Superior cerebellar

artery (SCA) arises from the basilar artery just below the PCA in the interpeduncular cistern, enter into the middle incisural space where it bifurcates into upper and lower trunk, these trunks enter into the cerebellomesencephalic fissure to reach the superior surface of cerebellum.

Venous relationships

Basal vein of Rosenthal courses middle incisural space to reach the posterior incisural space. Basal vein in both side terminate in the great vein of Galen along with internal cerebral veins. Basal vein of Rosenthal may rarely terminate in a tentorial sinus.

POSTERIOR INCISURAL SPACE

Cisternal relationships

Cisterns related to posterior incisural space are quadrigeminal cistern, pericallosal cistern and cerebellomesencephalic fissure. Among this quadrigeminal cistern is the major cistern located in the posterior incisural space. This cistern communicates with pericallosal cisterns which are situated superiorly.Quadrigeminal cistern communicates with cerebellomesencephalic fissure which is situated inferiorly between cerebellum and midbrain. Quadrigeminal cistern communicates infero laterally with ambient cistern. This cistern may have communication with velum interpositum which is the space in the roof of the 3rd ventricle.

Ventricular relationships

Ventricles related to posterior incisural space are, posterior part of 3rdventricle, atrium and occipital horns of lateral ventricle and aqueduct. Posterior part of 3rd ventricle located anterior to posterior incisural space.Atrium and occipital horns of lateral ventricle situated lateral to posterior incisural space and aqueduct situated anterior to posterior incisural space.

Arterial relationships

Arteries related to posterior incisural space are posterior cerebral artery (PCA), superior cerebellar artery (SCA), medial posterior choroidal arteries and lateral posterior choroidal arteries. In the lateral part of posterior incisural space PCA divides into parieto occipital and calcarine arteries.SCA courses in the posterior incisural space from middle incisural space and enter into cerebello mesencephalic fissure, from there it run towards postero superiorly to reach the tentorial surface of cerebellum.

Medial posterior choroidal arteries enter from the middle incisural space to posterior incisural space where it curve supero medially to reach the roof of third ventricle running between splenium of carpus callosum and pineal body. Medial posterior choroidal arteries supply the choroid plexus in the 3rd ventricle and in the body of lateral ventricle. Lateral posterior choroidal arteries reach the temporal horn of lateral ventricle, this artery supply the choroid plexus in the temporal horn and atrium of lateral ventricle.

Venous relationships

Posterior incisural space is most important area among the three incisural space because in this space many veins drain into great vein of Galen. Internal cerebral veins on exiting from the velum interpositum enter into posterior incisural space where it joins with great vein of Galen. Basal vein of Rosenthalrun from middle incisural space to posterior incisural space and enter

into vein of Galen. Many other veins like superior vermian vein, parieto occipital veins also drain into great vein of Galen. This usually turns upwards and drains into straight sinus.

Tentorial arteries

Common tentorial arteries are basal tentorial arteries, marginal tentorial arteries. Basal tentorial arteries arise from meningo hypophyseal trunk which is the branch of cavernous segment of internal carotid artery. Marginal tentorial artery arises from inferolateral trunk which is also arises from cavernous segment of internal carotid artery. If Marginal tentorial artery is absent, a branch from meningo hypophyseal trunk usually replaces it.Other sources of tentorial arteries are proximal part of posterior cerebral artery (PCA), superior cerebellar artery (SCA).

Clinical importance of tentorial incisura

Tentorial herniation

Tentorial herniation is the most important form of brain herniation. In descending herniation, uncus and parahippocampal gyri herniate inferiorly through the incisura, and in ascending herniation[14], superior part of cerebellum herniate upward through the tentorial incisura. This brain herniation cause, compression of vessels,stretchingand compression of the brainstem and cranial nerves[13].Compression of arteries cause arterial infarctionand compression of vein causes venous infarction, increasing the edema and elevation of ICP.In the herniation of the tentorial incisura and foramen magnum, it is believed to be caused by the progressive obliteration of subarachnoid space with the mass lesion.Thus, the important factor in preventing or treating herniation of the brain is maintenance of or re-establishment of the subarachnoid space at the site of the herniation occurs[15].

Type of tentorial herniation is depends on the position and rate of expansion of the lesion and size and shape of the incisura. Wide space between the free edge and brainstem facilitates cerebral herniation because more tissue can herniate into the incisural space. This herniation push the brainstem to opposite side, and thus increasing the space between free edge and the brainstem, thus facilitating a further shift of tissue through the tentorial aperture.

Pathology and operative approaches:

Most of the intracranial aneurysm usually arisesfrom the circle of Willis. Most of these aneurysms approached through the anterior middle or posterior incisural spaces. Example of some of the other tumours approached through this incisural spaces are sellar parasellar tumours like pituitary tumours,craniopharyngioma, glioma arising from optic nerves, opticchiasm, meningioma arising from tuberculam sellae, clinoid, and diaphragmasellae. Tumours commonly approached through posterior incisural spaces are pineal tumours,tectal tumours,splenial tumours etc…

Selection of best approaches for the tumours in and around tentorial incisura is depends on whether anterior middle or posterior incisural space involved.

Anterior incisural space:

More than ninety percentages of aneurysms are situated in the anterior incisural space. Aneurysm arising from internal carotid, middle cerebral artery and aneurysm arising from circle of Willis located in front of Lilliquist membrane approached through the fronto temporal craniotomy (pterional craniotomy)

Aneurysms located behind Liliequist's membrane in the basilar apex at the interpeduncular fossa can be exposed through either by a frontotemporal or sub temporal craniotomy if they located above the dorsum sellae.

Aneurysmslocated in prepontine cistern that is below the dorsum sellae may require anterior or mid sub temporal craniotomy.

For the surgery of lesions around the incisura[17] incising the tentorium or retraction of tentorium is necessary most of the times. For the incision of the tentorium, incision should be posterior to the point of tentorium where trochlear nerve joins the tentorial edge. Sectioning of the tentorium[18]also can be used rarely for reducing the supratentorial pressure and to reduce the pressure over the brainstem in the situation where the original pathology cannot be removed.

Lesions in the anterior incisural space can be approached by the bifrontal, sub frontal, frontal-interhemispheric,pterional,sub temporal, and transsphenoidal routes.

Middle incisural space

Approaches to middle incisural space include the posterior frontotemporal, sub temporal, temporal transventricular,and lateral sub occipital routes.Sub temporal approach is used for the lesions in and around the tentorial incisura. Doing craniotomy in the lower level has the advantage of lesser temporal lobe retraction and thus we can avoid complications like venous infarction,edema.Dividing tentorium increases the exposure to incisura. Partialresection of parahippocampal gyrus increases the exposure of upper part of incisural space. Sub temporal craniotomy can be combined with sub

occipitalcraniotomy with cutting of tentorium to remove the tumours in the prepontine cistern.

In transventricular approach incision made in the non-dominant middle temporal gyrus or inferior temporal gyrus, cortical incision also can be made in the occipitotemporal gyrus which is in the inferior surface of temporal lobe.

Posterior incisural space:

Common posterior incisural space lesions are pineal gland tumours.Glioma's arising from cerebellum,tectum,splenium and pulvinar. Meningioma's arising from falx, telachoroidea of atrium and posterior 3rdventricle. Other vascular lesions like aneurysm, vein of Galenmalformations. Posterior incisural lesions can be approached by occipital trans tentorial approach[2,19,20],infratentorial supracerebellar approach[21].Infratentorial supracerebellar and occipital transtentorial approaches, are most commonly selected for pineal region tumors, can be combined with incision of the tentorium lateral to straight sinus.

MATERIALS AND METHODS

Materials and methods

For cadaveric study, 10 cadavers in the Institute of Anatomy, Madras Medical College and Rajiv Gandhi Government General Hospital, Chennai, studied between January 2013 to December 2013.

For autopsy study, 15specimens in the Institute of forensic medicine, Madras Medical College and Rajiv Gandhi Government General Hospital, Chennai, studied between January 2013 to December 2013**.**

Inclusion criteria

1.10 cadavers from the Institute of Anatomy, Madras Medical College, during the study period

2.15 autopsy specimen from the Institute of forensic medicine, Madras Medical College, during the study period

Exclusion criteria

1. All cadaveric specimen which had damaged tentorium cerebelli on examination

2. All autopsy specimen which had damaged tentorium cerebelli on examination

3. Allpaediatricspecimen

In cadaveric study, tentorial incisura measured in 10 cadavers using vernier caliper after opening the skull and cutting the midbrain at tentorial edge

level carefully without damaging the tentorium. Measurements done in milli meters

Following parameters studied,

1) Anterior notch width, this is the width of the tentorial notch in the axial plane through the posterior aspect of the dorsum sellae

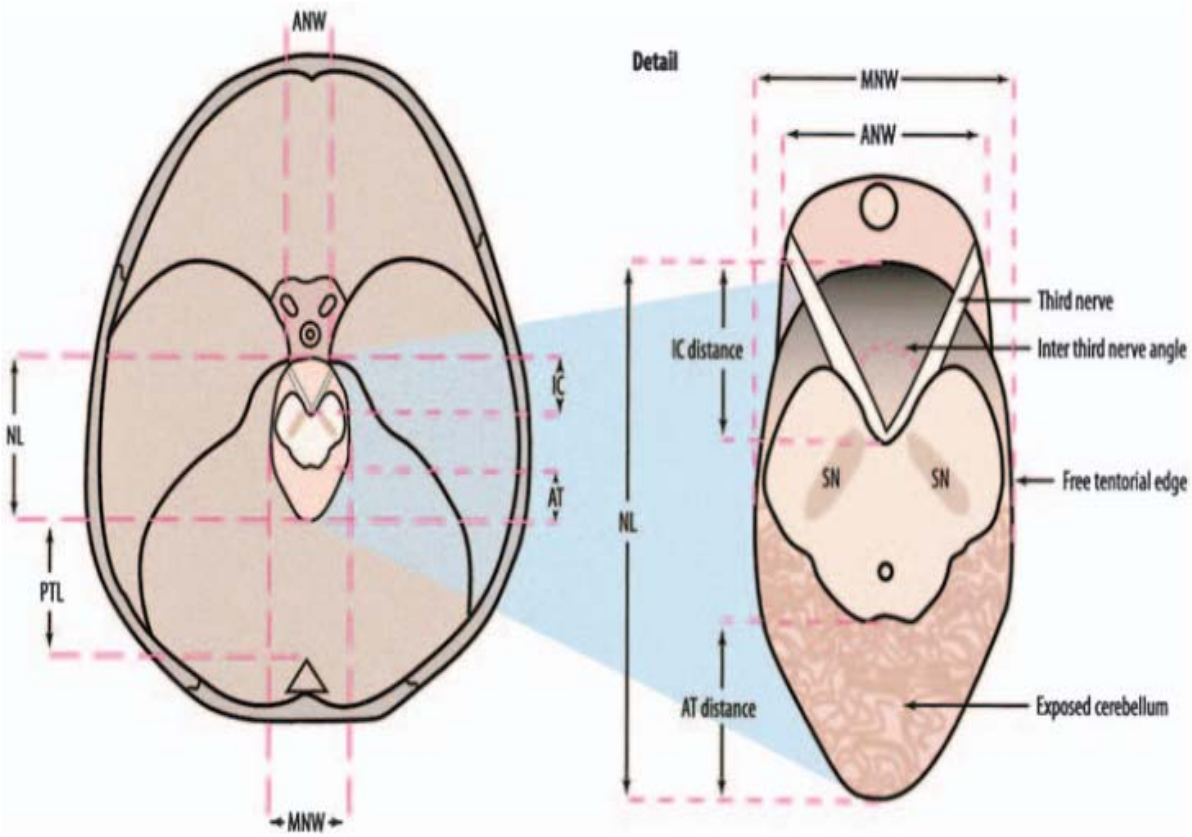
2) Maximum notch width (MNW), this is the maximum width of the notch in the axial plane

3) Notch length (NL), this is the length of the tentorial notch from the superoposterior edge of the dorsum sellae to the apex of the notch of tentorium

4) Posterior tentorial length (PTL), this is the shortest distance between the apex of the notch and the most anterior part of the confluence of sinuses

5)Interpedunculoclival (IC) distance, which is the distance from the interpeduncular fossa to the supero posterior edge of the dorsum sellae

6) Apicotectal (AT) distance, which is the distance from the tectum in the median plane to the perpendicular line dropped from the apex of tentorial notch to the cerebellum


ANW
NL
PTL
IC
AT
MNW
Detail
MNW
ANW
IC distance
NL
AT distance
SN
SN
Third nerve
Inter third nerve angle
Free tentorial edge
Exposed cerebellum

Among 10 cadavers, all the 6 parameters measured in 6 cadavers, in the remaining 4 cadavers brain was liquefied so IC(Interpedunculoclival)distance and AT(apicotectal) distance could not be measured as mid brain was not there because of liquefaction.

As available cadavers during the 1 year period was less in number, it was decided to do the study of the tentorial incisura in autopsy specimen also, and it was found during examination that tentorial and incisura size of cadaver is comparable with autopsy specimen and there was no gross variations of measurement between the two groups.

In autopsy specimen also above mentioned values (ANW, MNW, NL, PTL) except 2(IC distance and AT distance) measured after opening the skull and cutting the midbrain at the level of tentorial edge. IC distance and AT distance could not be measured here because in autopsy specimen midbrain was not rigid like cadaveric brain.

Name,age,sex of all the 15 autopsy cases noted, and these are retrospectively analyzed,admission GCS,CT findings, midline shift noted.

Out of 15 autopsy cases,4 cases are non-trauma cases with no CT findings.11 cases are trauma cases with positive findings in CT brain. Out of this 11 cases 4 cases operated immediately after admission because of their poor admission GCS and they had significant intracranial haematoma with significant midline shift(more than 5mm),these patients were managed medically appropriately after surgery but they died in the following days of

surgery.4 trauma cases, initially managed conservatively because of their good GCS and less midline shift(less than 5mm)in admission, but this 4 cases deteriorated in the following days in spite of appropriate medical management and all the 4 cases developed midline shift of more than 5 mm on deterioration. Admission GCS of remaining 3 cases were poor, and they managed conservatively throughout the period because there was no indication for surgery even in repeated imaging.

Following studies performed from the data

Mean value of ANW, MNW NL, PTL, IC DISTANCE, AT DISTANCE of all the 25 cases calculated which was compared with western population from the available study.

25percentile (1^{st} quartile) , 50percentile (2^{nd} quartile), 75percentile (3^{rd} quartile) values calculated for all the values except for AT and IC DISTANCE because this value was available only for 5 cadavers not for other cases.

Based on MNW and NL values incisura was classified into following 8 categories,

1. WIDE-MNW more than 3^{rd} quartile and NL between 1^{st} and 3rd quartile

2. NARROW-MNW less than 1^{st} quartile and NL between 1^{st} and 3^{rd}

Quartile

3. LONG- NL more than 3rd quartile and MNW between 1st and 3rd quartile

4. SHORT-NL less than1st quartile and MNW between 1st and 3rd quartile

5. TYPICAL- MNW between 1st and 3rd quartile and NL between 1st and 3rd Quartile

6. LARGE- MNW more than 3rd quartile and NL more than 3rd quartile

7. SMALL- MNW less than 1st quartile and NL less than 1st quartile

8. MIXED-MNW more than 3rd quartile and NL less than 1st quartile

Or NL more than 3rd quartile and MNW less than 1st quartile

Age dependent mean value calculated for all the 4 values (ANW, MNW, NL, and PTL)

All the 15 autopsy cases further divided into 5 age groups

20 to 25 years-2 cases

45 to 50 years-3 cases

51 to 55 years-5 cases

56 to 60 years-2 cases

61 to 65 years-3 cases

Cases in each group further classified according to the tentorial incisura size in which they fall based on previously described tentorial incisura classification.

For 11 trauma cases, rate of deterioration of GCS calculated, that is from admission till death, average deterioration of GCS per day calculated. All the 11 cases divided into 2 groups based on tentorial size, that is 1 st group is those who had large tentorial size (MNW more than 3rd quartile and NL more than 3rd quartile) and 2 nd group is others that is those who had other than large tentorial incisura. Rate of deterioration of GCS compared for this 2 groups to find out any significance between tentorial size and rate of deterioration of GCS.

Tentorium photos

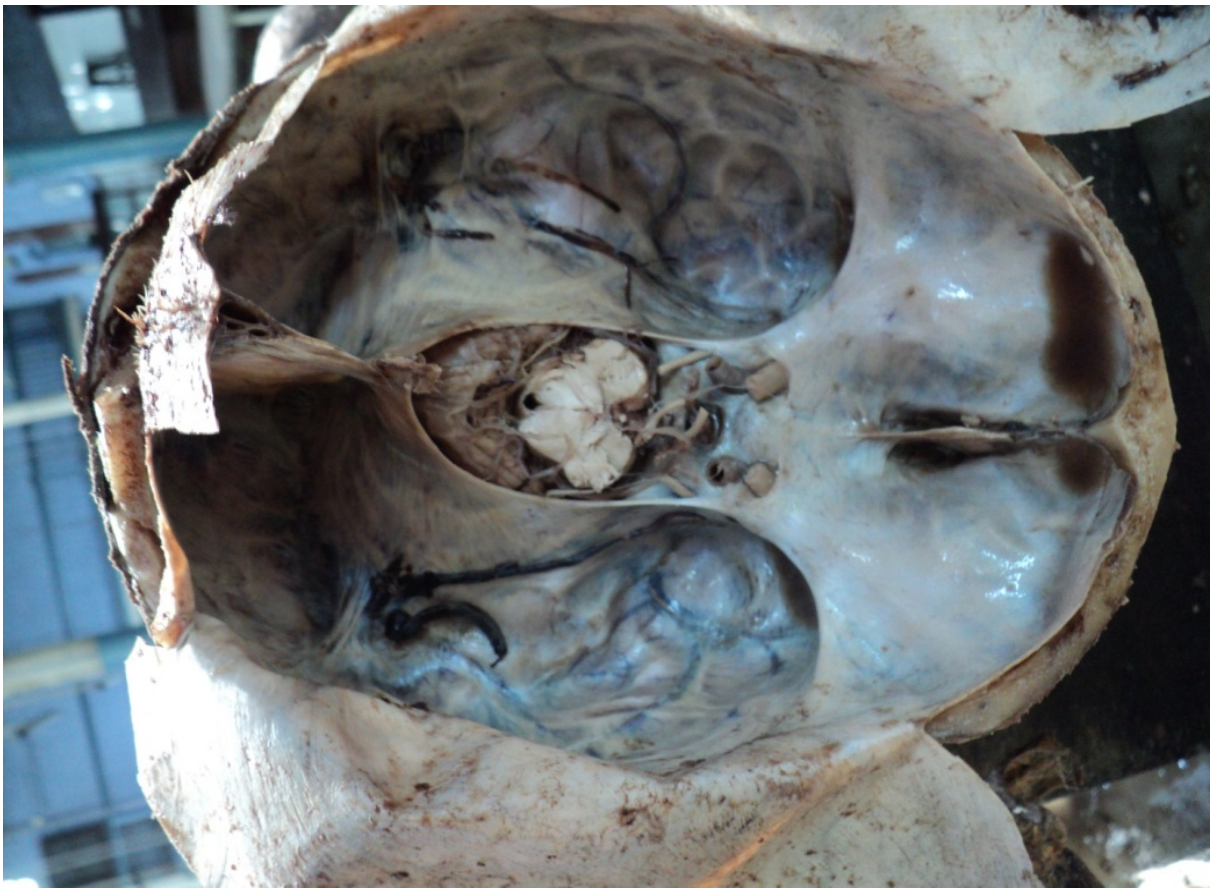


Photo-1

Tentorium photos

Photo-2

Tentorium photos

Photo-3

Tentorium photos

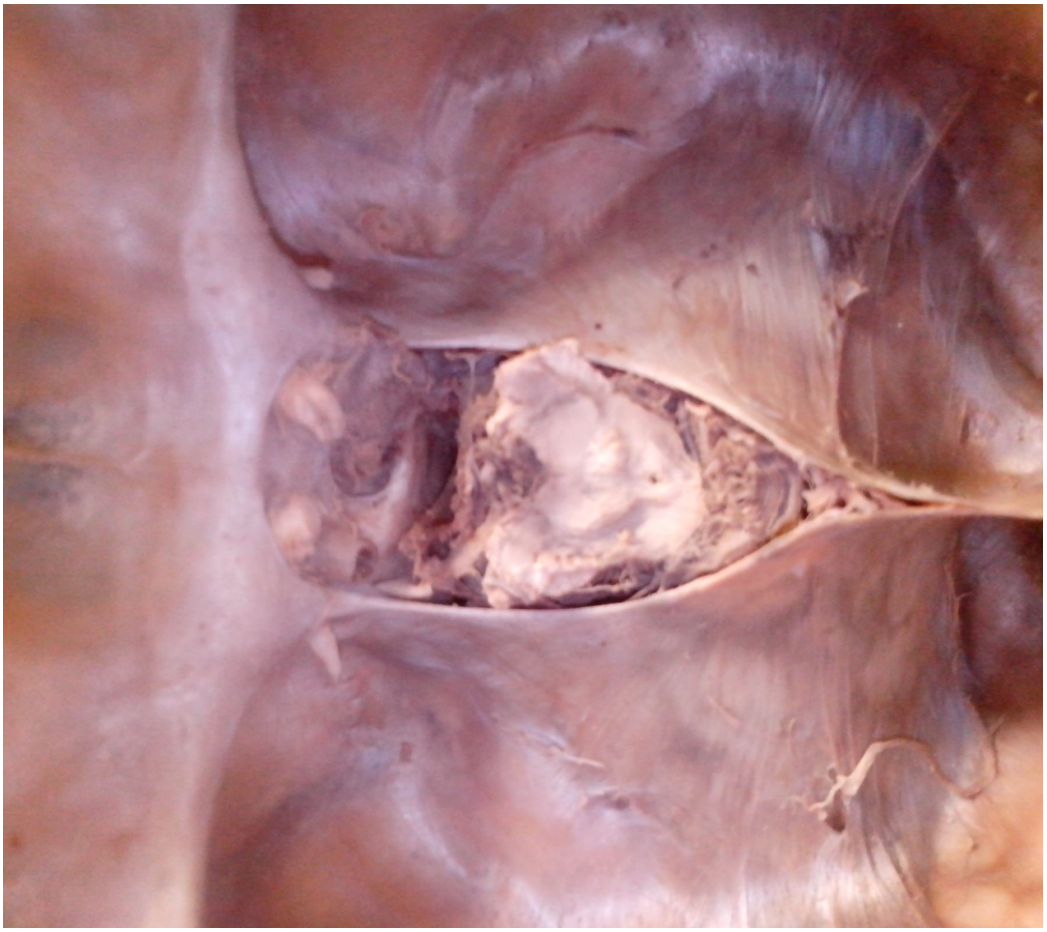
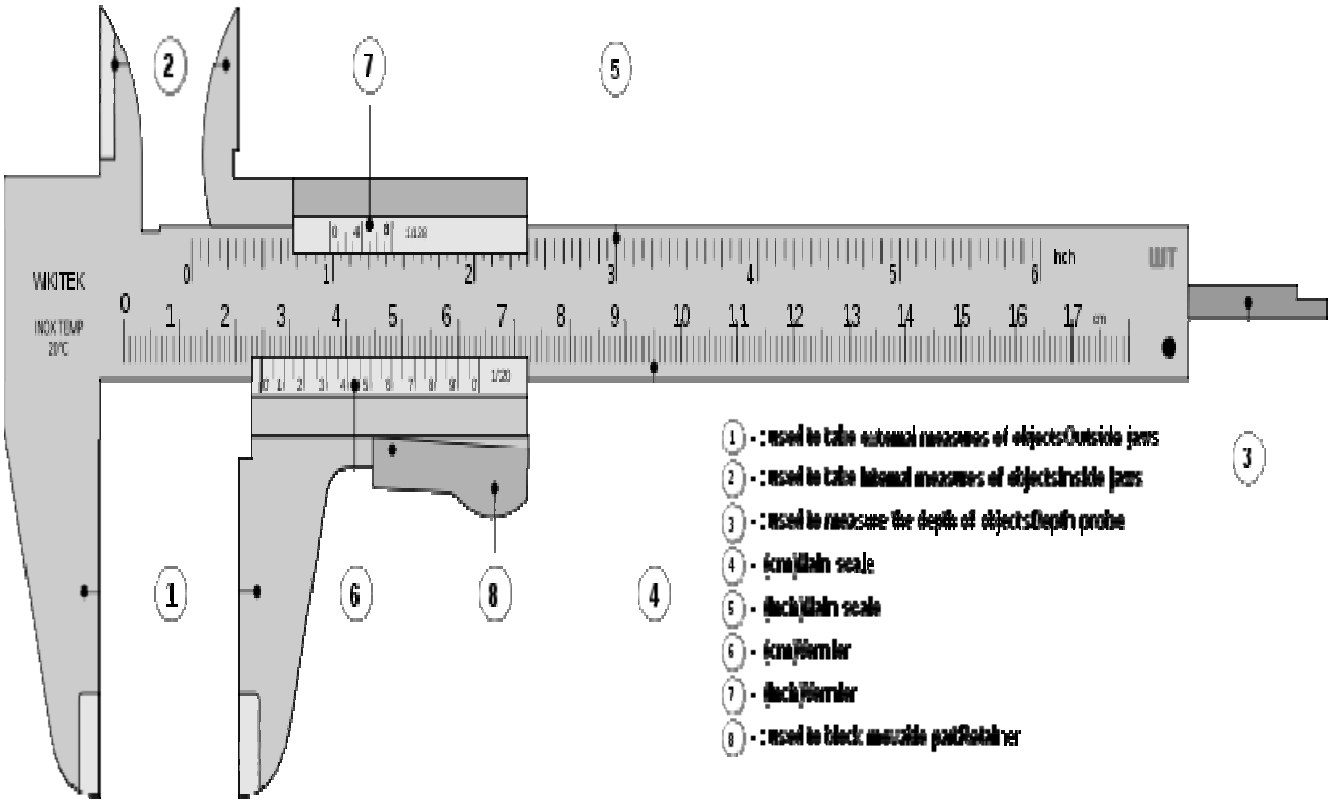


Photo-4



vernier caliper (used to take the measurements in this study)

STATISTICAL ANALYSIS AND RESULTS

Statistical analysis and results

Mean value of ANW, MNW NL, PTL, IC DISTANCE, AT DISTANCE of all 25 cases calculated

		ANW	MNW	PTL	NL	AT	IC
Mean		27.7024	30.7496	39.2604	53.8484	15.7475	11.815
Median		28.1000	32.0500	38.9800	56.0000	16.42	14.36
Std. Deviation		2.82120	3.89572	9.49341	6.67189	11.21627	7.580
Percentiles	25%	25.6900	27.1400	32.3200	48.6700		
	50%	28.1000	32.0500	38.9800	56.0000		
	75%	30.2000	33.0750	44.3400	59.6250		

Table1:Mean values of ANW, MNW NL, PTL, IC DISTANCE, AT DISTANCE and percentiles of ANW, MNW NL, PTL of 25 cases.

Result-1

Mean values of all the measurements are comparable with the western population from the available studies[22] in the literature. There was no significant variation of tentorial incisura found in our part of India.

Frequency and percentage of various types of incisura in our study,

GROUPS	FREQUENCY	PERCENT
WIDE	2	8%
NARROW	1	4%
SHORT	1	4%
LARGE	4	16%
TYPICAL	10	40%
LONG	1	4%
SMALL	5	20%
MIXED	1	4%

Table 2: Frequency and percentage of various types of

Incisura

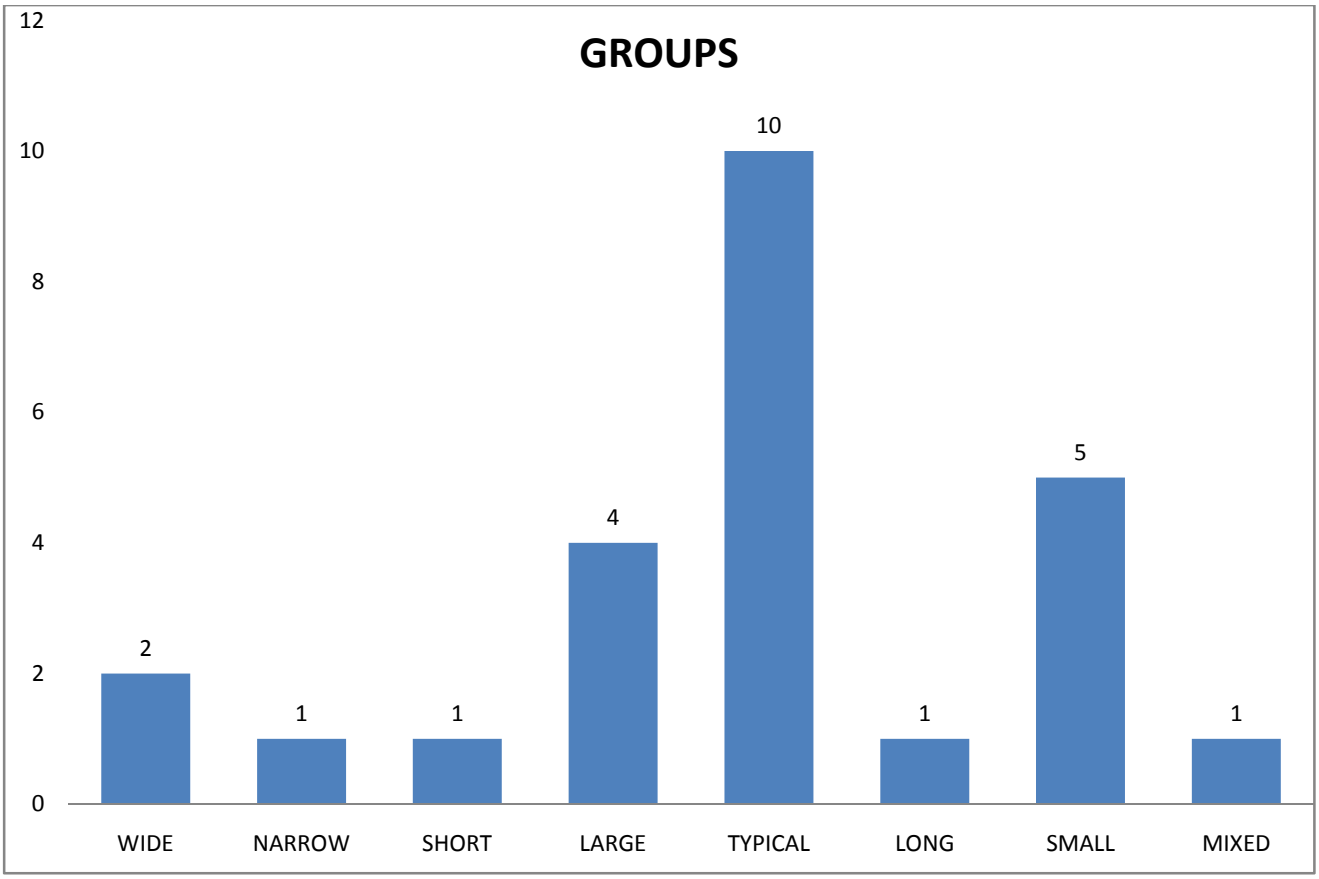


Chart 1: Frequency and percentage of various types of incisura

Result-2

Out of 25 cases, 10 cases had typical, 5 had small, 4 had large, and 2 had wide, and remaining 4 had narrow,short,long and mixed type of tentorial incisura each.

Age dependent mean value calculated for all the 4values (ANW, MNW, NL, PTL)

		ANW MEAN	MNW MEAN	PTL MEAN	NL MEAN
AGE GROUP	20 - 25 YEARS	22.1800	24.0500	43.1600	41.5000
	45 - 50 YEARS	29.0333	32.2667	32.7667	57.0667
	51 - 55 YEARS	29.1760	32.1880	30.6880	60.7380
	56 - 60 YEARS	28.5000	32.4250	33.7000	56.9000
	61 - 65 YEARS	28.2333	31.7400	32.8467	54.2167

Table 3: Age dependent mean value

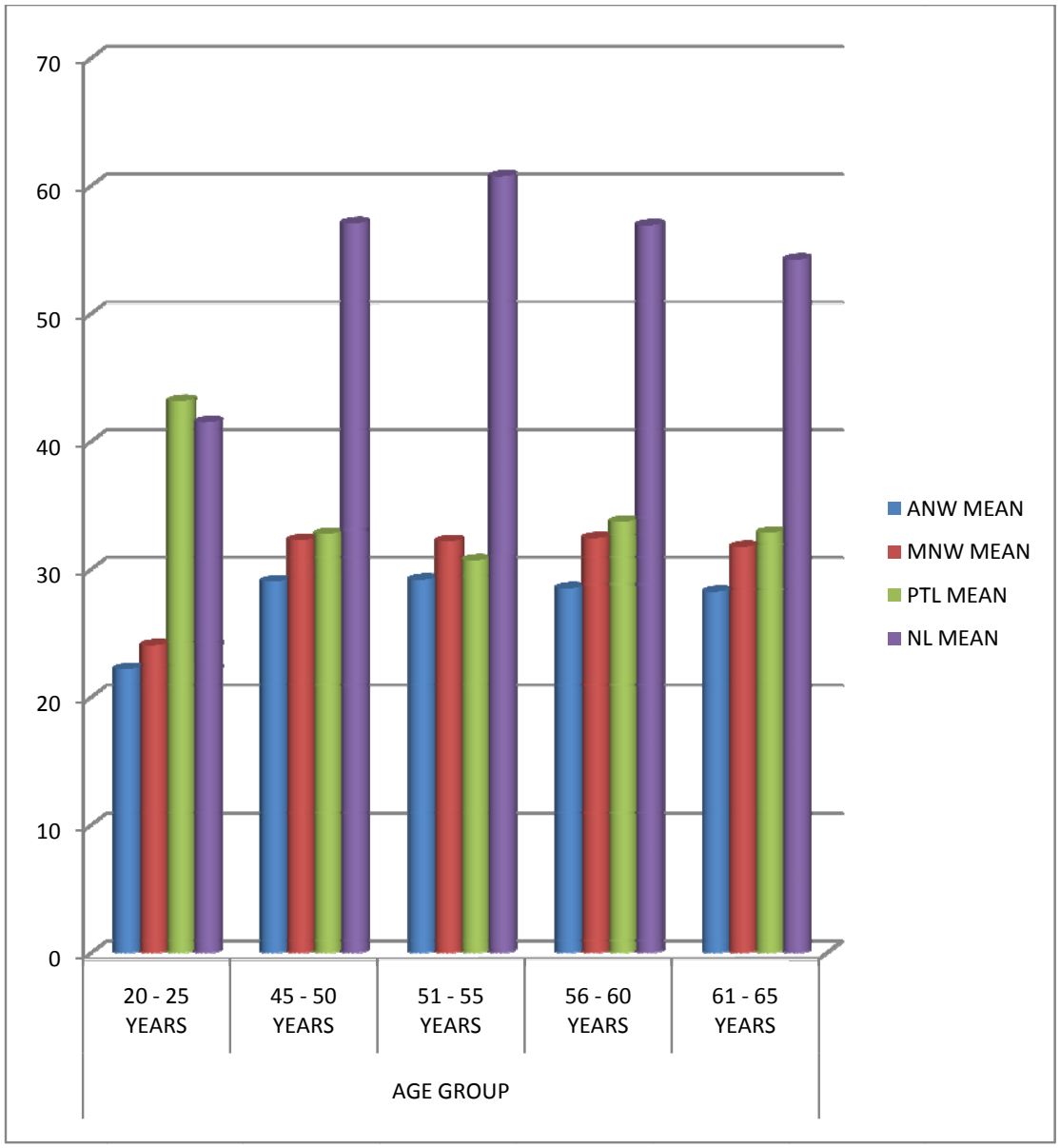


Chart 2: Age dependent mean value

Result-3

Among all the cases, tentorial size are significantly small in the age between 20 and 25(mean value of both ANW and MNW is less than 1st quartile).But after the age of 45 there is no significant variation of tentorial size depends on the age.

	TOTAL NUMBER OF CASES(15)	WIDE	NARROW	SHORT	LARGE	TYPICAL	LONG	SMALL	MIXED
20 - 25 YEARS	2							2	
45 - 50 YEARS	3				1	2			
51 - 55 YEARS	5				3		1		1
56 - 60 YEARS	2					2			
61 - 65 YEARS	3					3			

Table: 4 Age wise distribution tentorial incisura

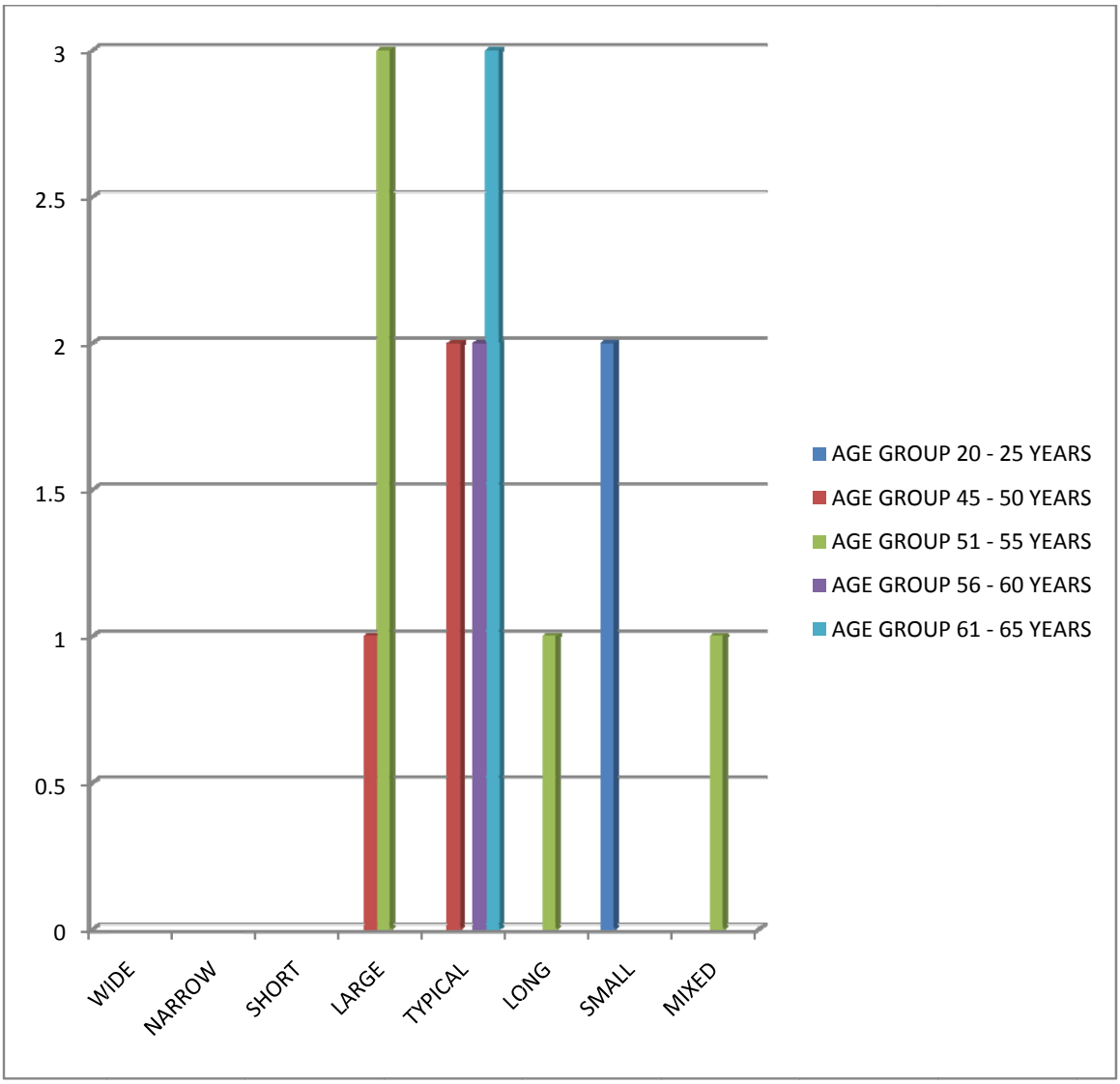


Chart 3: Age wise distribution tentorial incisura

Result-4

In age wise analysis between the ages of 20 to 25 all 2 cases were coming under small incisura, in 56 to 60 and 61 to 65 all the 5 cases were coming under typical, in other age group there is no preferential distribution.

All the 11 trauma cases divided into 2 groups. All the trauma patients who had large tentorial incisura(MNW more than 3rd quartile and NL more than 3rd quartile)considered as 1 stgroup, they are 4 in number, others are considered as 2 ndgroup, they are 7 in number. Mean value of Rate of deterioration of GCS per day for each group calculated and compared

	GROUP	NO OF PATIENTS	Mean	Std. Deviation
RATE OF DETORIORATION OF GCS	1.00	4	2.7300	.69995
	2.00	7	1.0329	1.11476

Table 5: comparison of rate of deterioration of GCS (per day) of 2 groups of Patients

T TEST:

	t	**df**	**p- value**	**Mean Difference**	**Lower**	**Upper**
RATE OF DETORIORATION OF GCS	-2.719	9	.024	-1.69714	-3.10918	-.28511

Table 6: T test to assess the significance

Result-5

Rate of deterioration GCS is higher in patents whohad large tentorial incisura compare to other groups which is statistically significance (p value-0.024)

Results:

1. Measurements of tentorial incisura in Indian population done to find out any demographic variation of tentorial incisura. The result is comparable with western population that is, there was no significant variation of tentorial incisura size compare to western population
2. On classification of tentorial incisura,Out of 25 cases,10 cases had typical,5 had small,4 had large,2 had wide, remaining 4 had narrow,short,long and mixed type of tentorial incisura each
3. On age wise distribution of tentorial size in15 autopsy cases,tentorial size is significantly small in the age between 20 and 25(mean value of both ANW and MNW is less than 1st quartile).But after the age of 45 there is no significant variation of tentorial size depends on the age.
4. On comparing the rate of deterioration of GCS (per day) of trauma patients who had large tentorial incisura(MNW more than 3rd quartile and NL more than 3rd quartile) with others,the rate of deterioration of GCS is significantly high in patients who had large incisura compare to others which is statistically significance(p value 0.024)

DISCUSSION

Discussion

Neural and vascular relationship in the tentorial hiatus is more complex. Tentorial incisural area contains carotid artery bifurcation, basilar artery bifurcation and circle of Willis. This is also related to deep intracranial venous system which converges to great vein of Galen. Neural structures related to tentorial incisura are cerebrum, cerebellum, olfactory, optic, occulomotor, trochlear, trigeminal, abducent nerve and midbrain.

The tentorial incisura is the opening which connects the supra and infratentorial spaces. There is a space between the midbrain and tentorial edges; this incisural space is divided into anterior incisural space, middle incisural space, and posterior incisural space[2]

The incisura is triangular in shape, base is situated anteriorly over dorsum sellae and apex is situated posteriorly dorsal to the midbrain and pineal gland..
As described earlier, incisural space is divided into 3 spaces,anterior, middle and posterior incisural spaces.

Tentorial herniation is the most important form of brain herniation. In descending herniation, uncus and parahippocampal gyri herniate inferiorly through the incisura, and in ascending herniation, superior part of cerebellum herniate upward through the tentorial incisura. This brain herniation cause, compression of vessels,stretching and compression of the brainstem and cranial nerves[13].Compression of arteries cause arterial infarction and compression of

vein causes venous infarction, increasing the edema and elevation of ICP.In the herniation of the tentorial incisura and foramen magnum, it is believed to be caused by the progressive obliteration of subarachnoid space with the mass lesion.Thus, the important factor in preventing or treating herniation of the brain is maintenance of or re-establishment of the subarachnoid space at the site of the herniation occurs.

Type of tentorial herniation is depends on the position and rate of expansion of the lesion and size and shape of the incisura. Wide space between the free edge and brainstem facilitates cerebral herniation because more tissue can herniate into the incisural space. This herniation push the brainstem to opposite side, and thus increasing the space between free edge and the brainstem, thus facilitating a further shift of tissue through the tentorial aperture.

There are only few studies in the literature, analysing the tentorial incisura and classification of incisura, and none of those are from Indianpopulation. Keeping in mind that there may be little demographic variations in the anatomy, it was decided to do the study of analysing tentorial incisura in the Indianpopulation. The studies available in literatures were analysed only the cadaveric tentorial incisura but no studies are available in the literature analysing fresh autopsy specimen. This study analysed both cadaveric and autopsy specimens tentorial incisura..

We also noticed in our study a strong relationship betweenlarge apertures and fast deterioration of patients because of tentorial herniation (which is also

supported by literature quoted earlier[2]).These findings may have implications regarding thepropensity for transtentorial herniation of cerebellar or cerebral parenchyma in the rostral or caudal direction, respectively.

From our study, we have noticed that, head injury patients admitted with good GCS (GCS more than 13) who had large tentorial incisura subsequently deteriorated fast compare to others who have lesser tentorial size, which is statistically significance.

CONCLUSION

Conclusion

A study of tentorial incisura involving 10 cadavers and 15 autopsy specimen has led to following conclusions

1No significant variations in the tentorial incisura measurements compare to western population.

2.Rate of deterioration GCS is higher in patients who had large tentorial incisura compare to other groups which is statistically significance. But this is to be confirmed by further study using large groups of patients to be used for clinical applications.

LIMITATIONS OF THE STUDY

Limitations

1. Number trauma patients used in this study is only 11.Study with large serious of patients is necessary to confirm the finding that the large tentorial incisura size is associated with high chance of tentorial herniation

2. Age wise distribution of patient is not equal, that is only 2 patients in age range between 20 to 25, and there is no patients between the ranges of 26 to 45, so age wise classification of tentorial incisura may not be accurate

3. All the cases analysed here are males. No female cases are there in our study, so variations in the tentorial size between sexes could not be analysed

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APPENDIX

PROFORMA

NAME: AGE/SEX:

IP NO:

DOA: DOD:

HEAD INJURY PATIENTS:

GCS:

ON ADMISSION:

1 st DAY:

2nd DAY:

3rdDAY:

4th DAY:

5th DAY:

RATE OF DETORIORATION OF GCS/DAY:

CT FINDINGS: YES/NO/NA:

SDH -

EDH -

BRAIN CONTUSION-

BRAIN STEM CONTUSION-

BASAL CISTERNS-

OTHER CT FINDINGS-

MID LINE SHIFT (mm):

ON ADMISSION:

1 st DAY:

2nd DAY:

3rd DAY:

4th DAY:

5th DAY:

TREATMENT: CONSERVATIVE/OPERATED

NON HEAD INJURY PATIENTS:

DIAGNOSIS:

CT FINDINGS:

TENTORIAL NOTCH MEASUREMENTS:

ANTERIOR NOTCH WIDTH (mm):

MAXIMUM NOTCH WIDTH (mm):

POSTERIOR TENTORIAL LENGTH (mm):

NOTCH LENGTH (mm):

APICO TECTAL DISTANCE (mm):

INTERPEDUNCULOCLIVAL DISTANCE (mm):

INSTITUTIONAL ETHICS COMMITTEE
MADRAS MEDICAL COLLEGE, CHENNAI -3

Telephone No : 044 25305301
Fax : 044 25363970

CERTIFICATE OF APPROVAL

To
Dr.S. Maria Subison,
P.G in Neuro Surgery,
Madras Medical College, Chennai -3

Dear S.Maria Subison,

The Institutional Ethics committee of Madras Medical College, reviewed and discussed your application for approval of the proposal entitled "Analysis of Tentorial Notch in Indian population and comparing it with western population and analyzing the relation between Tentorial Notch size and the outcome of Head Injury patients" No.03022013.

The following members of Ethics Committee were present in the meeting held on 05.02.2013 conducted at Madras Medical College, Chennai -3.

1.	Dr.SivaKumar, MS FICS FAIS	--- Chairperson
2.	Prof. R. Nandhini MD Director, Instt. of Pharmacology ,MMC, Ch-3	-- Member Secretary
3.	Prof. Shyamraj MD Director i/c , Instt. of Biochemistry , MMC, Ch-3	-- Member
4.	Prof. P. Karkuzhali. MD Prof., Instt. of Pathology, MMC, Ch-3	-- Member
5.	Prof. A. Radhakrishnan MD Prof of Internal Medicine, MMC, Ch-3	-- Member
6.	Prof. S. Deivanayagam MS Prof of Surgery, MMC, Ch-3	-- Member
7.	Thiru. S. Govindsamy. BABL	-- Lawyer
8.	Tmt. Arnold Saulina MA MSW	-- Social Scientist

We approve the proposal to be conducted in its presented form.

Sd/ Chairman & Other Members

The Institutional Ethics Committee expects to be informed about the progress of the study, and SAE occurring in the course of the study, any changes in the protocol and patients information / informed consent and asks to be provided a copy of the final report.

R Nandhini 11/3/13

Member Secretary, Ethics Committee

tentorial incisura study

ORIGINALITY REPORT

23%	4%	23%	1%
SIMILARITY INDEX	INTERNET SOURCES	PUBLICATIONS	STUDENT PAPERS

PRIMARY SOURCES

1	Albert L. Rhoton. "Tentorial Incisura", Neurosurgery, 09/2000 Publication	9%
2	Michio Ono. "Microsurgical anatomy of the region of the tentorial incisura", Journal of Neurosurgery, 02/1984 Publication	4%
3	www.columbianeurosurgical.net Internet Source	2%
4	Thomas W. Langfitt. "Transmission of Increased Intracranial Pressure", Journal of Neurosurgery, 11/1964 Publication	1%
5	Albert L. Rhoton. "The Lateral and Third Ventricles", Neurosurgery, 10/2002 Publication	1%
6	"Transcortical surgery for lateral ventricular tumors", Neurosurgical FOCUS, 06/2001 Publication	1%
7	Khaled A. Aziz. "Tentorial Meningiomas", Neurosurgery Quarterly, 03/2009 Publication	1%

MASTER CHART

S.NO	Tentorial incisura measurement in cadaver						
	ANW	MNW	PTL	NL	AT	IC	BRAIN LIQUIFIED
1	30.52	40.2	56.13	58.5	17.96	17.98	A
2	31.82	34.7	49.72	59.38	30.78	13.42	A
3	25.6	26.58	47.94	48.5	16.3	17.9	A
4	27.6	28.94	38.98	49.25	16.44	17.56	A
5	26.1	27.68	41.58	46.6	NA	NA	P
6	29.9	32.85	39.18	59.4	28.1	15.3	A
7	25.78	27.6	42.3	42.02	NA	NA	P
8	23.1	26.68	53.3	48.84	16.4	12.36	A
9	25.3	25.3	45.48	44.76	NA	NA	P
10	27.8	32.3	62.9	54.62	NA	NA	P

Tentorial incisura measurement in autopsy specimen-non trauma										
	ANW	MNW	PTL	NL	AT	IC	NAME	AGE	SEX	CT FINDINGS
11	27.8	32.3	38	54.3	NA	NA	SHANKAR	48	M	N
12	28.3	32.05	34	57	NA	NA	MUNUSAMY	58	M	N
13	28.1	31.2	33	56	NA	NA	KUMARAVEL	45	M	N
14	23.9	26.21	40.14	59.85	NA	NA	RAJEE	55	M	N

Tentorial incisura measurement in autopsy specimen-trauma

	ANW	MNW	PTL	NL	AT	IC	NAME	AGE	SEX	CT FINDINGS				GCS SCORE						TREATMENT	MIDLINE SHIFT(MM)		
										ACUTE SDH	EDH	BRAIN CONTUSION	BRAIN STEM CONTUSION	admission	2nd day	3rd day	4th day	5 th day	Rate of detorioration of GCS/day	OPERATED/CONSERVATIVE	ON ADMISSION	2 ND DAY	3rd DAY
15	28.7	32.8	33.4	56.8	NA	NA	MOHAN	57	M	P	A	A	A	7	7	6	E		1.25	CONSERVATIVE	NO SHIFT		
16	28.4	31.68	31.9	51.42	NA	NA	MUNIRATHINAM	65	M	P	A	A	A	6	5	E			1	OPERATED	10		
17	28.9	30.72	32.74	54.63	NA	NA	SHANMUGAM	65	M	A	P	P	A	4	4	E			0.34	OPERATED	8		
18	27.4	32.82	33.9	56.6	NA	NA	ARIVALAGAN	61	M	P	A	A	A	6	5	E			1	OPERATED	9		
19	21.68	24.3	43.12	42.8	NA	NA	PANCHANATHAN	23	M	A	A	A	P	3	E				0	CONSERVATIVE	NO SHIFT		
20	22.68	23.8	43.2	40.2	NA	NA	EDWIN	22	M	A	P	A	A	4	4	E			0.3	OPERATED	15		
21	30.78	32.83	29.8	61.54	NA	NA	BOOPATHY	52	M	P	A	A	A	13	10	E			3.34	OPERATED ON 2ND DAY	4	8	
22	30.9	34.1	28.3	60.3	NA	NA	DHANDABANI	53	M	P	A	A	A	14	11	E			3.67	OPERATED ON 2 ND DAY	5	8	
23	31.2	33.3	27.3	60.9	NA	NA	SHANKAR	49	M	P	A	A	A	13	13	11	E		2.5	OPERATED ON 3rd DAY	4	5	8
24	29.8	34.2	27.2	61.2	NA	NA	THIRUNAVUKARASU	51	M	P	A	A	A	13	12	9		7 E	2	OPERATED ON 3rd DAY	4	6	9
25	30.5	33.6	28	60.8	NA	NA	RAMESH	52	M	P	A	A	A	14	13	10	E		2.75	CONSERVATIVE	5	5	

Abbreviation used in master chart

ANW- Anterior notch width

MNW-Maximumnotch width

NL - Notch length

PTL- Posterior tentorial length

IC - Interpedunculoclival

AT-Apicotectal

A-Absent

P-Present

M-Male

N-Normal

GCS-Glasgow Coma Scale

E-Expired